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ORT OF SEDIMENTATION SURVEY

LAKE BALLINGER

RUNNELS COUNTY, TEXAS

1970

UNITED STATES
DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

4-30433 5-71
USDA-SCS-FORT WORTH, TEX. 1971

Report of Sedimentation Survey

LAKE BALLINGER

Runnels County, Texas

1970

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United States Department of Agriculture

Soil Conservation Service

Temple, Texas

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REPORT OF SEDIMENTATION SURVEY

LAKE BALLINGER
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REPORT OF SEDIMENTATION SURVEY

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INTRODUCTION

This report describes the results of a sedimentation survey of Lake Ballinger, Runnels County, Texas, made by the United States Department of Agriculture, Soil Conservation Service, Temple, Texas, in cooperation with the City of Ballinger. The survey was made at the request of the Runnels Soil and Water Conservation District, and was conducted during the period July 28 to August 5, 1970.

GENERAL INFORMATION

The reservoir is owned and operated by the City of Ballinger. The city applied for and was granted permission by the State Board of Water Engineers to impound 4,000 acre-feet of water and divert 1,000 acre-feet annually for municipal purposes. The lake also serves as a fishing and recreational area.

PURPOSE OF SURVEY

1. To determine capacity loss of the reservoir due to sedimentation.
2. To determine the annual rate of sediment production per unit of drainage area.
3. To determine the various sedimentation characteristics within the reservoir.
4. To determine the effects of conservation treatment and specifically the Valley Creek Watershed Project on sediment yield to the reservoir.

LAKE BALLINGER SYSTEM

Location - Lake Ballinger is located 6 miles west of Ballinger, Runnels County, Texas. The dam is constructed across Valley Creek approximately three river miles upstream from its confluence with the Colorado River.

Description of Dam and Spillway - The dam is an earthen fill structure 2,550 feet long with a maximum height above the original stream bed of 40 feet. The crown width is 20 feet, of which 16 feet is covered with an eight inch gravel blanket to serve as a roadway. The maximum base width is 170 feet. The embankment has a 2:1 slope on the downstream side. The upstream slopes are 3:1 from the base to elevation 1684.5 above mean sea level and 2.5:1 above that elevation. The upstream slope has approximately 18 inches of riprap covering a six inch inner gravel blanket.

The service spillway is located at the west end of the dam and has a crest elevation, determined by this survey, of 1694.0 feet above msl. The

service spillway width is 500 feet. An emergency spillway, 1400 feet wide, is located at the east end of the dam. The low water discharge is a concrete drop inlet structure which discharges into a pipe extending through the embankment. An intake tower is located on the east shoreline. Water is pumped directly from here by the City of Ballinger for municipal water supply.

The Reservoir - Storage began in Lake Ballinger in the fall of 1947. The original surface area of the lake at service spillway crest elevation was 352.20 acres, and the original capacity was 3,872.09 acre-feet, as determined by this survey.

THE WATERSHED

General Description - Valley Creek rises in Nolan County, Texas approximately 20 miles southeast of Sweetwater. It flows generally toward the southeast across the southwestern corner of Taylor County and then south through Runnels County to Lake Ballinger. The distance of flow from the headwaters to the dam is approximately 37 miles. Cottonwood Creek and Spring Creek are major tributaries which join Valley Creek in the upper reaches of the watershed. Fish Creek and Hisaw Creek are other major tributaries which join Valley Creek in the middle and lower reaches. The watershed has a drainage area of 210 square miles, or 134,400 acres.

Topography and Geology - The topography ranges from steeply sloping to nearly level. The lower 60 percent of the watershed is a rolling to nearly level plain where the geologic strata are northwesterly dipping Permian shales, limestones, and dolomites of the Clear Fork Group and sandstone of the Double Mountain Group. These formations are overlain in the northern portion of the watershed by part of a large Edwards Plateau outlier of nearly horizontal Cretaceous sands and weak sandstones belonging to the Trinity Group and shales and hard limestones of the Fredericksburg Group. Valley Creek and its upper tributaries have incised steep valleys through the protective hard limestone caprock into the weaker sands and sandstones, forming areas of pronounced relief. Elevations in the watershed range from 2,560 feet above mean sea level in the Edwards Plateau to 1,678 feet, the present low elevation in Lake Ballinger. The flood plain is generally broad and poorly defined, but in the upper reaches it is narrow and confined between steep upland slopes.(1)

Climate - The climate is warm and semi-arid. The mean monthly temperature ranges from 44 degrees Fahrenheit in January to 83 degrees in July. The normal frost free period of 226 days extends from March 28 through November 9. The average annual rainfall is 22.63 inches, as recorded at the U.S. Weather Bureau gage at Ballinger. Precipitation is fairly well distributed throughout the year, but is heaviest during April, May, June, September, and October.

Land Resource Areas and Soils - Approximately 40 percent of the watershed lies within the Edwards Plateau Land Resource Area and is used almost exclusively as rangeland. The soils are primarily calcareous, stony, shallow to very shallow clays on the upland and deep, fine textured, moderately

permeable soils along the streams. The Trinity sands and sandstones are covered by gravelly caliche deposits which preclude extensive cultivation of the sandy soils. These formations of the Trinity Group are part of the Cross Timbers Land Resource Area which comprises about 2 percent of the watershed area. The remaining 58 percent of the watershed lies within the Central Rolling Red Plains Land Resource Area and is intensively cultivated except for the steeper valley slopes. Soils[2] are predominantly deep, fine textured, and slowly to moderately permeable. The dominant soil series found in the watershed are Abilene, Mereta, Roscoe, Potter, Spur, Tarrant, Rowena, Portales, and Brackett.

Land Use - The overall land use for the watershed is as follows:

Land Use	Acres	Percent
Cropland	51,824	39
Rangeland and Pasture	79,007	59
Lake Area	352	--
Miscellaneous 1/	3,217	2
Total	134,400	100

1/ Includes roads, highways, towns, etc.

Erosion and Sediment Production - The estimated annual rate of total gross erosion in the watershed from 1947 to construction of the Valley Creek Watershed project in 1964 was 1.90 acre-feet per square mile. Sheet erosion accounted for approximately 48 percent, gully and streambank erosion 2 percent, and floodplain scour 50 percent of the total erosion. The latter type of erosion was estimated to be the main source of sediment deposited in Lake Ballinger.[1]

At the date of survey, the majority of the accelerated land treatment practices as provided for in the Valley Creek Work Plan had been established, and 75 percent of the structural measures had been completed. As a result, the average annual rate of total gross erosion in the watershed had been reduced an estimated 1.06 acre-feet per square mile. With the combined program, it is estimated that the average annual gross erosion has been reduced from 418 to 222 acre-feet.

The average annual sediment yield to the reservoir is 17.6 acre-feet. The reservoir has an estimated trap efficiency of 88 percent. The density of submerged sediment is only 37 pounds per cubic foot as compared to a density of 85 pounds per cubic foot for in-place soil. This results in an average annual capacity loss due to sediment deposition of 35.16 acre-feet. Comparison of the average annual estimate of erosion to the annual sediment yield shows a sediment delivery ratio of only five percent.

SURVEY METHODS AND CALCULATIONS

A line of levels was run to establish the service spillway crest elevation and to set a temporary bench mark on a pier piling. Permanent range end markers were established to aid in any future surveys which may be made.

The following survey procedures were used:

1. The map of the shoreline at service spillway crest contour was prepared by a combination of plane table mapping and use of existing aerial photographs. Elevations were taken from the T.B.M. to the water surface and then to the range ends by use of a dumpy level. Ranges, previously located on aerial photographs, were established by use of a transit.

2. A steel airplane cable was stretched from shore to shore on line between range ends. A boat with a line meter was then attached to the cable.

3. As the boat traversed along the range, distances were recorded. Water depths and sediment thickness measurements were made at regular intervals.

4. Water depths were measured with a standard 5-pound conical-shaped sounding pea attached to a copper-cored graduated line. Sediment thicknesses were obtained with sounding poles and grooved spud bars.

5. Sediment samples were obtained with a piston-type sampler which employs an inner plexiglass tube. Sample recovery was good, and representative samples were submitted for testing.

Original and present capacities were computed using the prismoidal formula as described by Eakin and Brown.(3)

Plottings of representative range cross sections showing the original and present elevations are shown in figure 4.

Area and capacity curves were constructed using a contour map plotted from the present water depth measurements taken during this survey.

SEDIMENTATION IN THE RESERVOIR

Character of Sediment - Seven sediment samples were taken from the reservoir, one from each of the first seven ranges. Samples from ranges 1 through 4 were almost identical in texture. They consisted of 88 percent clay and 12 percent silt size particles. Samples from ranges 5 through 7 were also almost identical in texture. They consisted of 73 percent clay and 27 percent silt size particles. The sediments are dark brown in color.

Distribution of Sediment - As shown by the segment data, Table 2, the greater capacity losses due to sediment are in segments 8, 9, 10, and 11. From segment 11 to the head of the lake, the backwater is confined within the original stream channel. When high inflows occur, sediment is deposited in greater quantities in the segments (8, 9 and 10) where the lake

begins to widen appreciably while a gradual buildup of sediment progresses upstream as evidenced by the capacity loss in segment 11. The reservoir has an over all capacity loss of 20.7 percent.

Volume Weight of Sediment - All samples were taken from areas of the reservoir which have not been exposed to air drying. The first four samples, previously described as being the finer textured sediments, also had a lighter average unit dry weight. These samples averaged 33 pounds per cubic foot. The last three samples had an average unit dry weight of 42 pounds per cubic foot and are considered to be representative of the sediment deposited in the upper segments of the lake. Due to the length of the sampler and the shallow water depths, samples could not be obtained above range 7. The unit dry weight of all 7 samples averaged 37 pounds per cubic foot. The average unit dry weight of upland soil samples is 85 pounds per cubic foot.

Trap Efficiency of Reservoir - The trap efficiency of sediment for Lake Ballinger is 88 percent. This was obtained by using curves developed by Brune[4] which relate capacity-inflow to the percent of sediment trapped.

SOIL CONSERVATION

Conservation treatment on lands in the watershed is carried out under the direction of the Runnels, Middle Clear Fork, and the Upper Clear Fork Soil and Water Conservation Districts assisted by the Soil Conservation Service work units in Ballinger, Abilene, and Sweetwater. These work units have assisted farmers and ranchers in preparing soil and water conservation plans on 126,444 acres (97 percent of agricultural land) within the watershed and have given technical assistance in establishing and maintaining the planned measures. To date approximately 79 percent of the planned practices have been applied.

The Valley Creek Watershed Project, which encompasses all of the watershed above Lake Ballinger, has had a significant effect in reducing sediment yield to the lake. At the date of survey, 15 of the 20 planned floodwater retarding structures had been completed and land treatment measures have increased by 19 percent. As a result of the combined program, the average annual gross erosion in the watershed has been reduced by 47 percent and sediment yield to the lake reduced by 12 percent.

SUMMARY

Lake Ballinger, as shown in Table 1, has lost 801.76 acre-feet of its original capacity due to sedimentation during its 22.8-year life. The average annual rate of deposition is 35.16 acre-feet, which represents a rate of 0.17 acre-foot per square mile of drainage area.

The total capacity loss of the reservoir to date is 20.7 percent, or almost 1.0 percent annually. This is a comparatively high capacity loss considering that the annual sediment yield to the reservoir is quite low for a drainage area of this size. The loss in capacity is due primarily to the

very low capacity-watershed ratio which provided only 18.5 acre-feet of storage for each square mile of drainage area. A practical minimum for this C/W ratio from the standpoint of sediment deposition in reservoirs is 100 acre-feet per square mile.

Conservation treatment measures by farmers and ranchers and the Valley Creek Watershed Project have reduced annual gross erosion by 47 percent and sediment yield by 12 percent.

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REFERENCES

1. U. S. Dept. of Agriculture, Soil Conservation Service, Work Plan Valley Creek Watershed, Texas, February 1962.

2. U. S. Dept. of Agriculture, Soil Conservation Service, Soil Survey of Runnels County, Texas, March 1970.

3. Eakin, H. M., Silting of Reservoirs, U. S. Dept. of Agriculture Tech. Bull. 524 (Revised by C. B. Brown), 166 pp. illus., 1939.

4. Brune, G. M., Trap Efficiency of Reservoirs, Trans. American Geophys. Union, Vol. 34, No. 3, pp 407-418, June 1953.

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RESERVOIR SEDIMENT
DATA SUMMARY
SCS-34 Rev. 6-66

TABLE 1

LAKE BALLINGER
NAME OF RESERVOIR

DATA SHEET NO.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DAM

1. OWNER City of Ballinger	2. STREAM Valley Creek	3. STATE Texas
4. SEC. TWP. RANGE	5. NEAREST P. O. Ballinger	6. COUNTY Runnels
7. LAT. 31° 45′ 29″ LONG. 100° 02′ 30″	8. TOP OF DAM ELEVATION 1704.5	9. SPILLWAY CREST ELEV. 1694.0

RESERVOIR

10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, ACRES	13. ORIGINAL CAPACITY, ACRE-FEET	14. GROSS STORAGE, ACRE-FEET	15. DATE STORAGE BEGAN
a. FLOOD CONTROL					
b. MULTIPLE USE	1694.0	352.20	3872.09	3872.09	11-47
c. POWER					16. DATE NORMAL OPER. BEGAN
d. WATER SUPPLY					
e. IRRIGATION					
f. CONSERVATION					11-47
g. INACTIVE					

17. LENGTH OF RESERVOIR	2.25 MILES	AV. WIDTH OF RESERVOIR	0.44 MILES

WATERSHED

18. TOTAL DRAINAGE AREA	210 SQ. MI.	22. MEAN ANNUAL PRECIPITATION	22.63 (68) INCHES
19. NET SEDIMENT CONTRIBUTING AREA	209 SQ. MI.	23. MEAN ANNUAL RUNOFF	1.25 INCHES
20. LENGTH 38.0 MILES	AV. WIDTH 5.53 MILES	24. MEAN ANNUAL RUNOFF	13,999 AC.-F T.
21. MAX. ELEV. 2560	MIN. ELEV. 1678	25. ANNUAL TEMP.: MEAN	64°F RANGE 44°F - 83°F

SURVEY DATA

26. DATE OF SURVEY	27. PERIOD YEARS	28. ACCL. YEARS	29. TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT.	31. SURFACE AREA, ACRES	32. CAPACITY, ACRE-FEET	33. C/I. RATIO, AC.-FT. PER AC.-FT.
11-47	--	--	Range (D)	15 Ranges	352.20	3872.09	0.28
8-70	22.8	22.8			352.20	3070.42	0.22

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, ACRE-FEET			36. WATER INFL. TO DATE, AC.-FT.	
		a. MEAN ANNUAL	b. MAX. ANNUAL	c. PERIOD TOTAL	a. MEAN ANNUAL	b. TOTAL TO DATE

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET			38. TOTAL SED. DEPOSITS TO DATE, ACRE-FEET		
	a. PERIOD TOTAL	b. AV. ANNUAL	c. PER SQ. MI.-YEAR	a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ. MI.-YEAR
8-70	801.67	35.16	0.17	801.67	35.16	0.17

26. DATE OF SURVEY	39. AV. DRY WGT., LBS. PER CU. FT.	40. SED. DEP., TONS PER SQ. MI.-YR.		41. STORAGE LOSS, PCT.		42. SED. INFLOW, PPM	
		a. PERIOD	b. TOTAL TO DATE	a. AV. ANN.	b. TOT. TO DATE	a. PERIOD	b. TOT. TO DATE
8-70	37 (7)	137	137	0.91	20.7	--	--

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET BELOW, AND ABOVE, CREST ELEVATION											
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION											

26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGTH OF RESERVOIR													
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	-105	-110	-115	-120	-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														

45. RANGE IN RESERVOIR OPERATION

WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.	WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.

46. ELEVATION–AREA–CAPACITY DATA

ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY
		(See Area & Capacity Curves, Figure 3)						

47. REMARKS AND REFERENCES

48. AGENCY MAKING SURVEY Soil Conservation Service-Texas

49. AGENCY SUPPLYING DATA Sedimentation Survey Party

50. DATE 3-67

USDA-SCS-HYATTSVILLE, MD. 1966

April 1966

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TABLE 2

SEGMENT DATA
LAKE BALLINGER
1970 SURVEY

SEGMENT	ORIGINAL SURFACE AREA (Acres)	ORIGINAL CAPACITY (Ac.-Ft.)	CAPACITY AT DATE OF SURVEY (Ac.-Ft.)	SEDIMENT VOLUME (Ac.-Ft.)	CAPACITY LOSS (Percent)
1	19.10	289.57	237.52	52.05	17.97
2	48.80	758.38	631.34	127.04	16.75
3	44.60	704.01	578.73	125.28	17.80
4	41.00	568.20	456.90	111.30	19.59
5	71.90	718.17	579.91	138.26	19.25
6	54.10	412.06	312.70	99.36	24.11
7	36.20	225.55	157.82	67.73	30.03
8	11.20	62.42	37.60	24.82	39.76
9	6.20	34.18	16.23	17.95	52.52
10	6.10	32.05	13.84	18.21	56.82
11	3.60	17.89	8.97	8.92	49.86
12	1.80	13.07	9.54	3.53	27.01
13	1.20	11.04	8.52	2.52	22.83
14	2.60	12.68	9.65	3.03	23.90
15	1.00	1.81	1.52	0.29	16.02
16	2.80	11.01	9.63	1.38	12.53
Total	352.20	3872.09	3070.42	801.67	20.70

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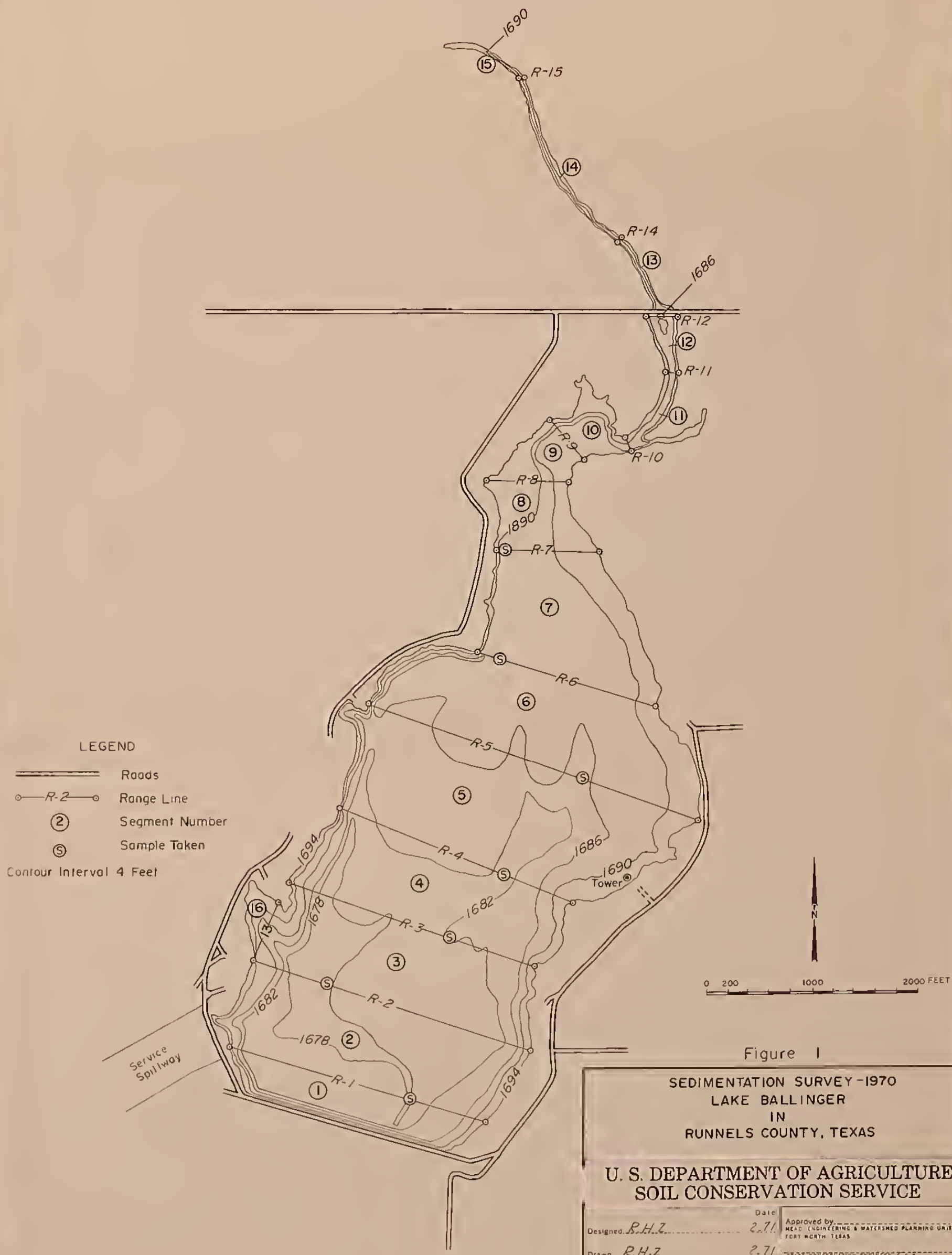
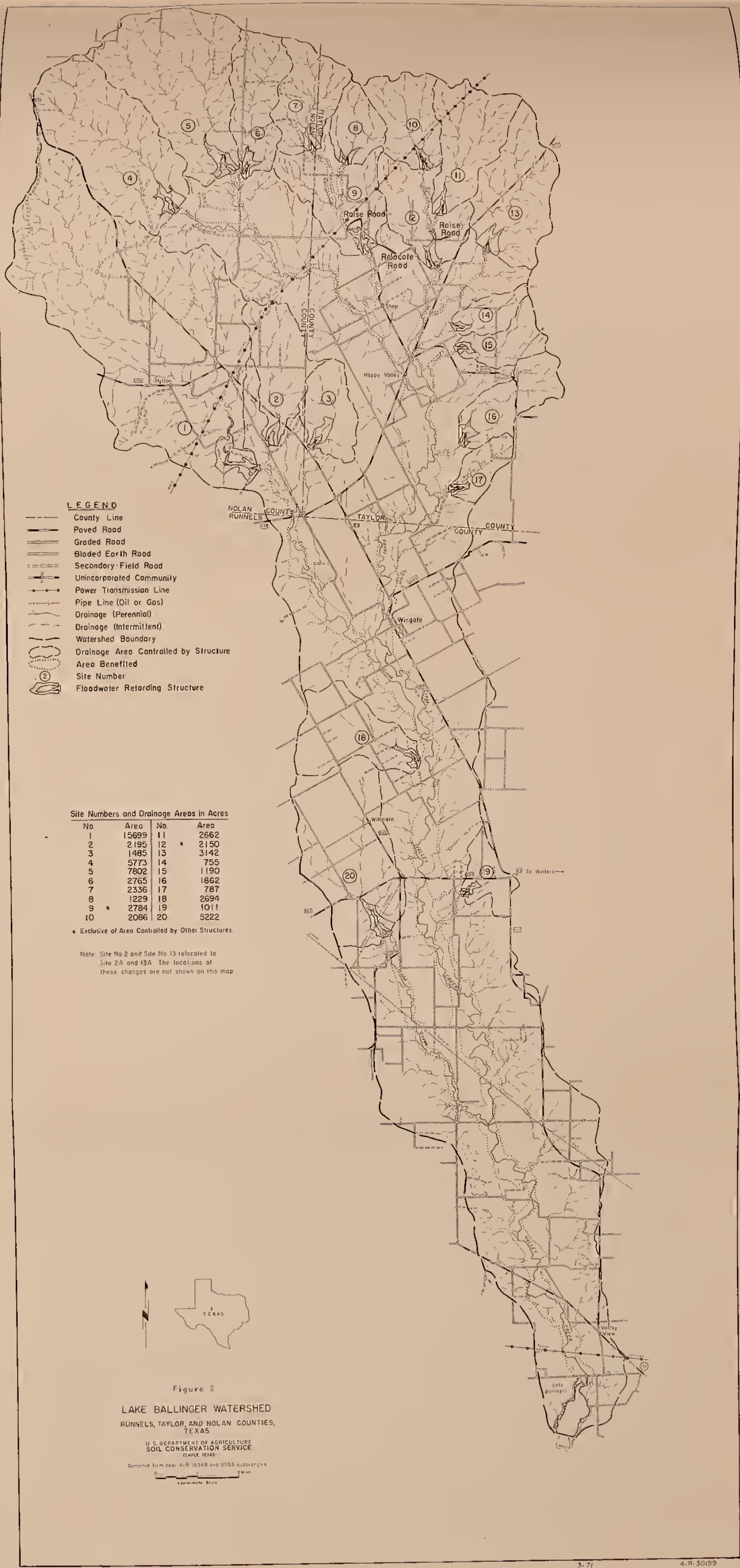


Figure 1

SEDIMENTATION SURVEY - 1970
LAKE BALLINGER
IN
RUNNELS COUNTY, TEXAS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed R.H.Z	2-71	Approved by HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
Drawn R.H.Z	2-71	STATE CONSERVATION ENGINEER, S.C.S. TEMPLE, TEXAS
Traced B.P.	2-71	Sheet No. of
Checked		Drawing No. 4-E-30185



Site Numbers and Drainage Areas in Acres

No.		Area	No.		Area
1		15699	11		2662
2		2195	12	*	2150
3		1485	13		3142
4		5773	14		755
5		7802	15		1190
6		2765	16		1862
7		2336	17		787
8		1229	18		2694
9	*	2784	19		1011
10		2086	20		5222

* Exclusive of Area Controlled by Other Structures.

Note: Site No 2 and Site No 13 relocated to Site 2A and 13A. The locations of these changes are not shown on this map

Figure 2

LAKE BALLINGER WATERSHED

RUNNELS, TAYLOR, AND NOLAN COUNTIES, TEXAS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

Compiled from best 4-R 1034B and USGS quadrangles

Approximate Scale

3-71

4-R-30199

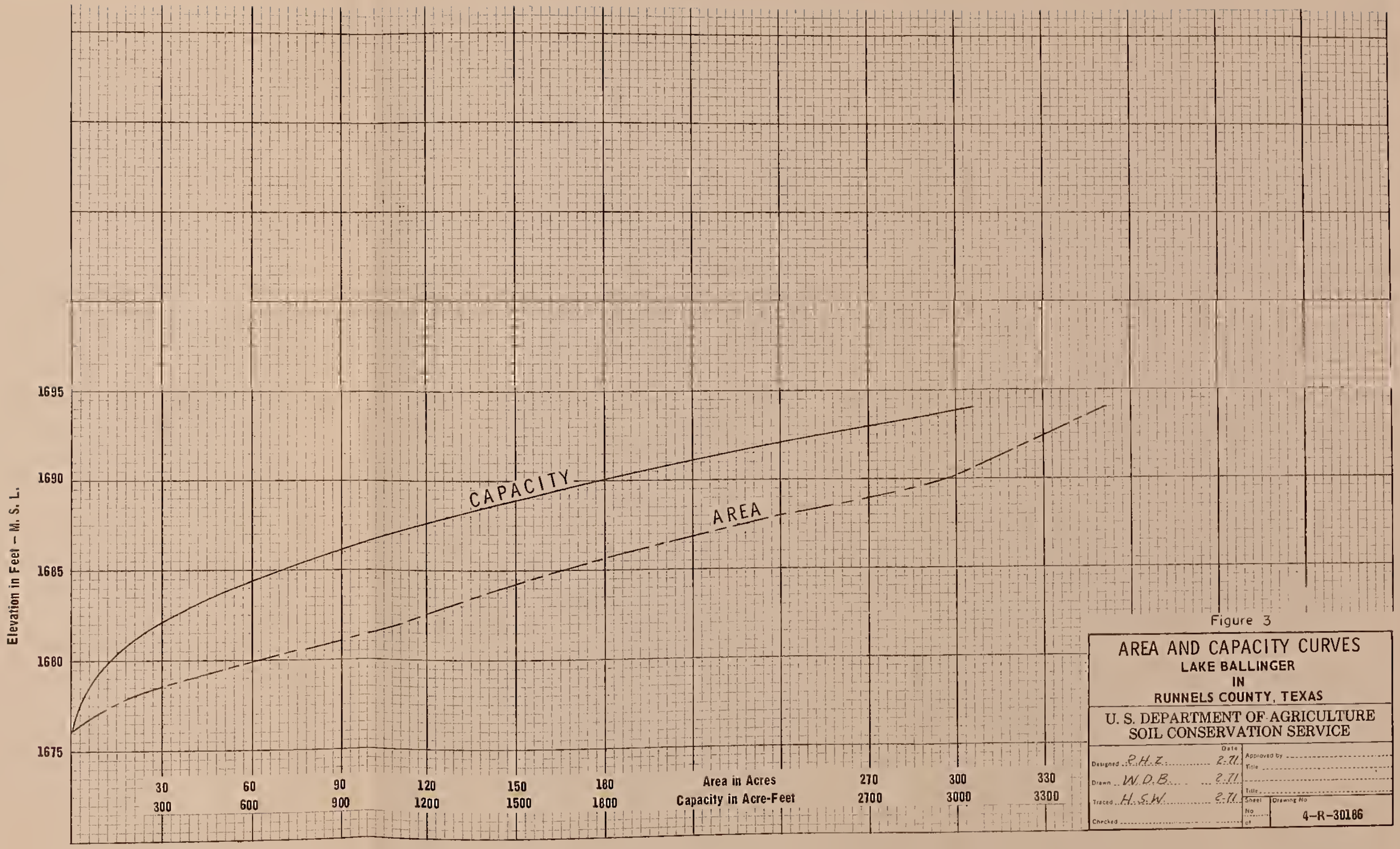


Figure 3

AREA AND CAPACITY CURVES
LAKE BALLINGER
IN
RUNNELS COUNTY, TEXAS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed P.H.Z.	2-71	Approved by	
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Traced H.S.W.	2-71	Title	
Checked		Sheet No. of	Drawing No. 4-R-30186

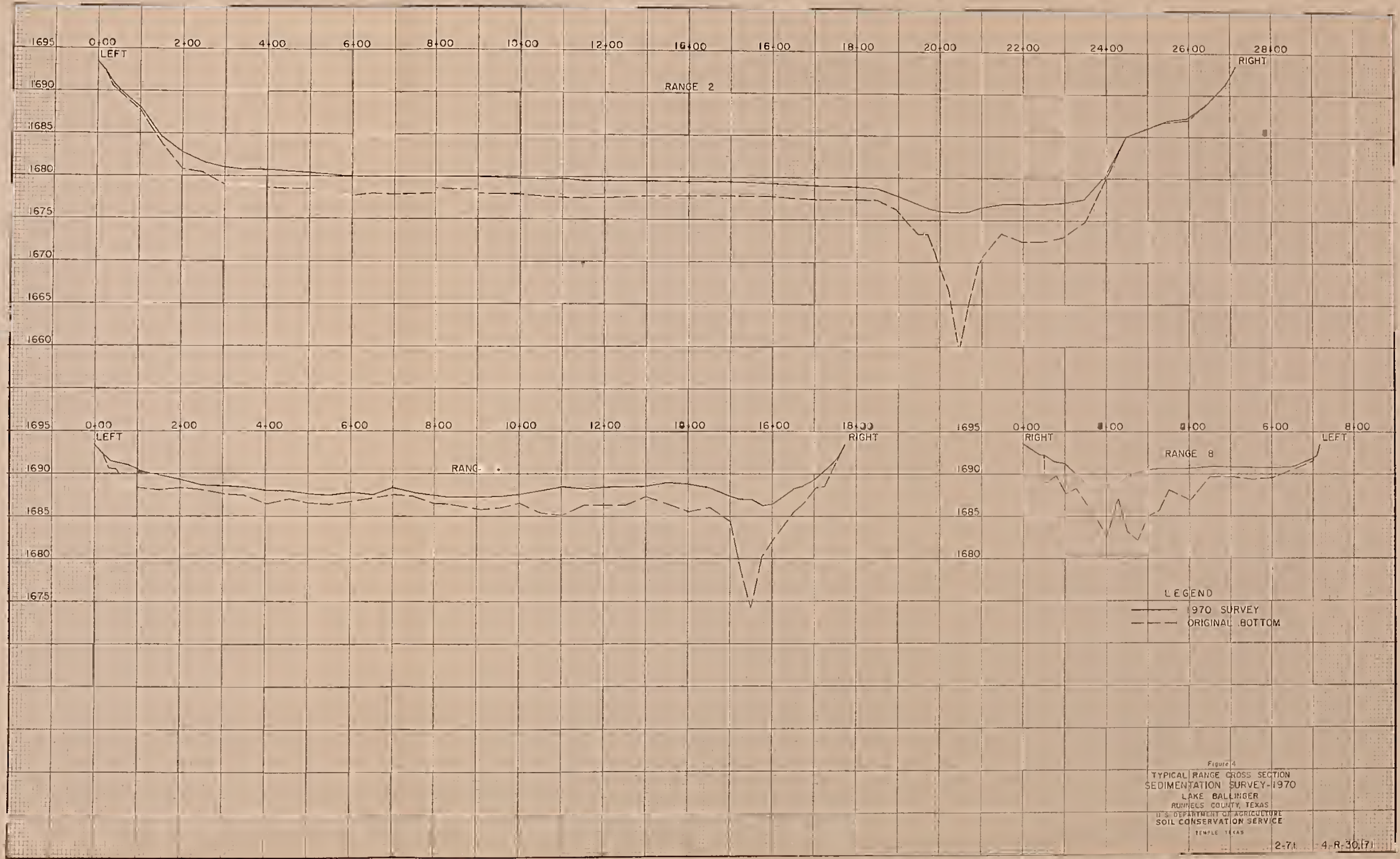

Figure 4

TYPICAL RANGE CROSS SECTION
SEDIMENTATION SURVEY-1970
LAKE BALLINGER
RUNNELS COUNTY, TEXAS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

2-71 4-R-30,171